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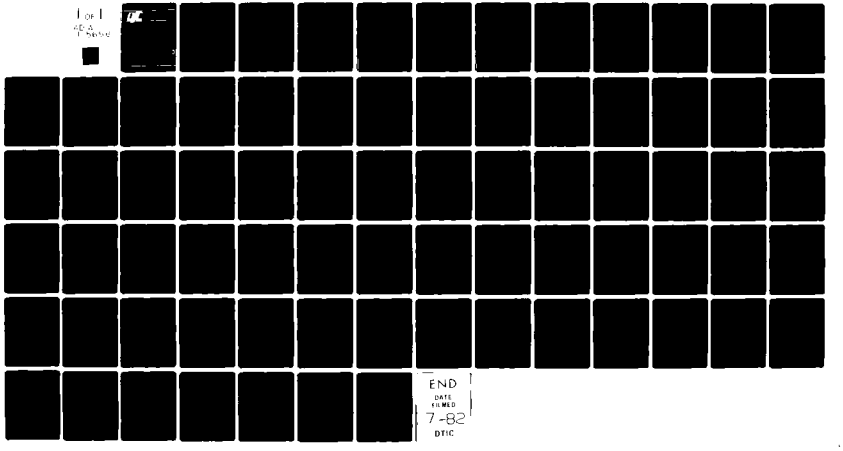

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TECHNICAL REPORT 82-3

FORECASTING INTERNATIONAL AFFAIRS: AN EMPIRICAL TEST OF A MARKOV RENEWAL MODEL

by

James O. Chinnis, Jr.

Sponsored by

Defense Advanced Research Projects Agency
Under Contract MDA903-81-C-0218

Under Subcontract from

Perceptronics, Inc.

June 1982

Decision Science Consortium, Inc.
7700 Leesburg Pike, Suite 421
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A major difficulty for designers of systems to forecast international affairs has been to allow the use of both observable data and subjective estimates. Under DARPA sponsorship, a novel approach has been developed by other contractors based upon a Bayesian stochastic model.

The present report discusses an experimental test of the approach in an actual intelligence setting. In this experiment, both direct subject probabilistic forecasts and those generated by computer models performed well. There was

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some suggestion that the direct assessments might be better for short-term forecasts and that the computer models might be most valuable in longer-term forecasting (30 days and longer) in dynamic situations.

ACKNOWLEDGEMENT

We wish to acknowledge the role of a large number of researchers who have been involved in the development of ideas, models, and computer software required for the experiment herein. Especially critical was the cooperation, time, and assistance provided by analysts at the Defense Intelligence Agency.

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1.0 INTRODUCTION

The accurate prediction of international events has been a major goal of researchers for some time. An approach relying on a Bayesian Markov-renewal model has been developed recently under sponsorship of the Defense Advanced Research Projects Agency (DARPA) by Drs. George Duncan and Brian Job (Duncan and Job, 1977; Duncan, 1977; Job, 1977) and implemented on a DARPA PDP-11/70 computer system by Mr. James Allen of Response Resource, Inc. An analysis of the general approach has been conducted earlier, but without benefit of actual data (Chinnis et al., 1981).

An opportunity to evaluate the forecasting system (referred to as "PREDICT") arose in June of 1981 when the Defense Intelligence Agency (DIA) agreed to develop and use a number of PREDICT-implemented models for a period of several months, with analysts providing daily inputs. An experimental test was planned which would permit a comparison of direct probabilistic forecasts made by the analysts each day with probabilistic forecasts made by the computer model. Actual models were constructed by the analysts under the supervision of Dr. Lou Johnson of Courtland International. DSC's primary role was to analyze the resulting data and produce the evaluation presented in this report.

2.0 EXPERIMENTAL DESIGN

Six models were constructed, each of a different world situation. Each model was constructed by a different analyst. That analyst assisted in the defining of five states representing a mutually exclusive and reasonably exhaustive partitioning of a continuum ranging from relatively peaceful (state 1) to relatively war-like (state 5). The same analyst also provided the required model inputs such as transition waiting times. Finally, the analyst provided on a daily basis an evaluation of the state actually observed on that day (which was supplied to the computer model).

In addition to the assessment of the current state on each day, each analyst made direct, unaided, forecasts of the probability of observing each of the five states, five, ten, and thirty days in the future. These direct, unaided, forecasts were made without any knowledge of the corresponding computer-generated forecast.

3.0 EVALUATION APPROACH

The evaluation of a forecast, let alone a forecasting method, is far from straightforward. Ideally, the penalty associated with assigning non-zero probability to an event (or state) which does not occur should depend upon the consequences of decisions made based upon the forecast. For obvious practical reasons such an evaluation would be impossible in most settings.

3.1 Ranked Probability Score

A number of reasonable approaches to forecast evaluation are available, however, and three were selected for the present situation. Of primary interest is the ranked probability score (RPS) originally developed to evaluate weather forecasts (Murphy, 1970). The RPS assigns an increasing penalty to the probability assigned to states progressively distant from the actual observed state. Technical details are concisely presented in Murphy (1970). Essentially the RPS is appropriate for estimating the expected utility of a forecast when the distinct states can be placed along a continuum representing the severity of some subject of interest (weather originally, and political unrest in the present case).

As used here, the RPS assigned to each forecast of five state probabilities ranges from a best score of one (when a categorical forecast of the correct state is made) to a worst score of zero (when a categorical forecast of state 1 or state 5 is made and the opposite state is later observed). Note that while the maximum RPS is one regardless of which state occurs, the minimum RPS depends upon the state which occurs. In the present context, this reflects the reality that the degree to which a forecast can be a bad one is limited when moderate outcomes occur (such as state 3) but is severe when extreme outcomes actually occur (such as state 5).

In mathematical terms, the RPS when state j occurs and $\underline{r}$ represents the vector of probability estimates across states is designated as $RPS_j(\underline{r})$, and can be expressed as

$$RPS_j(\underline{r}) = (3/2) - (1/8)\sum_{i=1}^{4}\left[\left(\sum_{n=1}^{i} r_n\right)^2 + \left(\sum_{n=i+1}^{5} r_n\right)^2\right]$$

$$- (1/4)\sum_{i=1}^{5} |i-j| r_i .$$

3.2 Brier Score

Although the political models constructed for the present evaluation are characterized by five states of increasing severity, as required by the RPS method, an argument might be made that the nature of the particular models is such that only the uppermost state is of real concern. In other words, it is possible that the RPS treatment of probabilities assigned to the various states is inappropriate because of a discontinuity in terms of costs of errors associated with state 5: correctly predicting the "war" is all that matters. For such a case, an appropriate measure of forecast quality is the Brier score, usually referred to simply as the probability score, PS. The PS, as used here, is equivalent to the RPS for the special case of a two-state model (state 5 and not state 5). Thus the best possible PS is one and is achieved by assessing a probability of one on the state which actually occurs, and the worst possible PS is zero and is achieved by assessing a probability of one (a "categorical" forecast) on the wrong state. Note that unlike the RPS for five-state models, the minimum PS does not depend upon which state actually occurs.

Mathematically, when state j occurs, the PS used here can be defined as

$$PS_j(\underline{r}) = 1 - r_i^2 \qquad (i \neq j).$$

3.3 Mean Absolute Error

A third measure of forecast quality which is simple to comprehend, if less appropriate to use, is the mean absolute error (MAE). This is simply the probability-weighted distance in terms of number of states by which the forecast is in error. For example, estimating a probability of one on state 3 when state 4 occurs is an MAE of one; a probability of one on state 3 when state 5 occurs is an MAE of two; a probability of 0.5 on state 1 and 0.5 on state 2 when state 3 occurs is an MAE of 1.5, and so on.

Mathematically, when state j occurs, the MAE can be defined as

$$MAE_j(\underline{r}) = \sum_{i=1}^{5} |i-j| r_i .$$

Note that MAE ranges from a best score of zero for a categorical forecast of the correct state to a worst score of four for a categorical forecast four states distant from the correct state. MAE, like the RPS, has a minimum which depends upon the actual state. Its use in the present evaluation is to assist our intuition as to the magnitude and importance of any differences in aided versus unaided forecasts.

4.0 RESULTS

The data employed in this evaluation are presented in raw form in the Appendices. In this section, the summary data are presented for RPS, PS, and MAE as obtained for each of three time periods and six models. In all cases, although the computer models were run for every day (by supplying the observed states when analysts became free to provide them), absences by analysts and the necessity to compare aided and unaided forecasts only when both were available, meant that gaps were generated at the same points for both aided and unaided data.

4.1 Appropriateness of the Models for Evaluation

In order to achieve a good opportunity to compare aided (PREDICT computer-generated) and unaided forecasts it is necessary to have (1) sufficient data to obtain precise estimates of the various scores, (2) appropriate model difficulty, and (3) a reasonable number of state changes. Appropriate model difficulty means that the forecasting task was neither so difficult that equiprobable forecasts result (0.20 on each state each day) or so easy that near-perfect forecasts were always produced. State changes are necessary to assure that the forecasters can adapt to such changes appropriately (and because non-trivial models should undergo state changes over time). For the six models (named Alpha through Lambda) the total number of days on which forecasts could be compared and the distribution of those observations across the five model states is shown in Table 1.

Table 1: Distribution of Observations Across States

Model	State 1	2	3	4	5	Total
Alpha	0	3	25	49	38	115
Beta	0	0	83	0	0	83
Gamma	0	57	77	0	0	134
Delta	128	0	0	0	0	128
Epsilon	0	0	0	132	0	132
Lambda	0	107	6	0	0	113
					Total	705

From the table, it is clear that only one model (Alpha) exhibits much coverage of the five states. Three of the models (Beta, Delta, Epsilon) remain fixed in the initial state throughout the four to five month experiment. For those models, examination of the data reveals that both the aided and unaided forecasts placed exactly or very nearly 100% probability on the fixed state; in other words, these problems were too easy to generate useful evaluation data. It should be noted that these models were probably selected as representing likely areas of change and intelligence interest which never materialized.

4.2 Comparison of Evaluation Scores

The average RPS, PS, and MAE scores for the Alpha model are shown in Table 2. Shown also are the standard errors of the mean RPS and PS, and the number of observations in each state. All data are broken down by time period of forecast.

Table 2: Summary Data for Model Alpha

	Forecast Period					
	5-day		10-day		30-day	
	aided	unaided	aided	unaided	aided	unaided
mean RPS	0.888	0.914	0.894	0.919	0.892	0.873
std error of mean	0.008	0.009	0.005	0.008	0.010	0.009
mean PS	0.739	0.822	0.717	0.785	0.822	0.696
std error of mean	0.015	0.018	0.019	0.021	0.014	0.029
mean MAE	0.825	0.748	0.829	0.747	0.878	0.950
distrib of observations:						
state 1	0		0		0	
state 2	2		0		1	
state 3	12		9		6	
state 4	35		36		21	
state 5	35		34		31	
Total	84		79		59	

From the table, two conclusions can be drawn immediately. First, both the unaided and aided forecasts do quite well according to all measures computed. At the most intuitive level, the mean absolute error is in all cases less than one state: forecasts are, on the average, always less than one state distant from the true state. Second, the aided forecast is not as good as the unaided forecast in the case of five- and ten-day forecasts, but is superior to the unaided forecast in the case of 30-day forecasts. The differences appear to be large relative to the precision of the measures as indicated by the standard errors of the means.

Further statistical analysis of the data is made extremely difficult by a number of factors. First, it is not possible to compare without qualification the scores obtained for the different forecast periods. This is because forecasts produced on the same day are scored against the observed state on different days, five, ten, and thirty days later. This is particularly serious for the RPS and MAE scores, which depend directly (independent of the forecast) on the observed state. Second, while it was hoped that the six models constructed by six different analysts would provide a reasonable sample of the possible PREDICT applications, since five of the six models exhibited almost no state changes and nearly perfect forecasts by both analyst and computer, only the single Alpha model remains as our sample. Thus generalizations cannot be supported.

To assist in interpreting the magnitude of the observed differences in RPS, consider as a baseline forecasting system one which assesses each day a uniform forecast across the five states. Such a system assumes that the five states represent reasonable possibilities for the particular problem but cannot say which are more likely than others. The formula for RPS in such a case reduces to

$$RPS_j(0.2,0.2,0.2,0.2,0.2) = 1.2 - 0.05 \sum_{i=1}^{5} |i-j|.$$

For the Alpha model the resulting RPS scores would be 0.795, 0.791, and 0.776 for the 5- , 10- , and 30-day periods, respectively. If the RPS scores for the Alpha model less the baseline scores are divided by unity less the above baseline scores, scores are produced which represent the fraction of possible improvement above the baseline achieved by the different forecasts. Such "normalized" scores are shown in Table 3.

Table 3: Alpha RPS Scores Renormalized

	Forecast Period					
	5-day		10-day		30-day	
	aided	unaided	aided	unaided	aided	unaided
mean RPS'	0.454	0.580	0.492	0.612	0.518	0.433
std error of mean	0.004	0.006	0.003	0.005	0.006	0.004

From the table, for the five-day forecasts, the PREDICT-generated forecast achieves 45.4% of the potential improvement from the baseline uniform forecast, while the unaided analyst achieves a 58% improvement. Thus either the aided or unaided forecasts are worth on the order of half the amount one should be willing to pay for a perfect forecasting system. To the extent that the baseline system is a pessimistic baseline, these percentages should, of course, be less.

Summary results for models Beta through Gamma are shown in Tables 4 through 8. In all cases, for these models, forecasts are so nearly perfect that these data are not considered further. For the models with little or no state-changing activity studied here, both the unaided analysts' direct probability

Table 4: Summary Data for Model Beta

	Forecast Period					
	5-day		10-day		30-day	
	aided	unaided	aided	unaided	aided	unaided
mean RPS	.999	1.000	.938	.999	.902	.992
std error of mean	.000	.000	.000	.000	.001	.000
mean PS	1.000	1.000	1.000	1.000	1.000	1.000
std error of mean	.000	.000	.000	.000	.000	.000
mean MAE	.090	.025	.700	.086	.897	.264
distrib of observations:						
state 1	0		0		0	
state 2	0		0		0	
state 3	76		71		51	
state 4	0		0		0	
state 5	0		0		0	
Total	76		71		51	

Table 5: Summary Data for Model Gamma

	Forecast Period					
	5-day		10-day		30-day	
	aided	unaided	aided	unaided	aided	unaided
mean RPS	.923	.955	.876	.919	.925	.925
std error of mean	.011	.005	.011	.011	.006	.005
mean PS	.989	.999	.982	.998	.981	.997
std error of mean	.002	.000	.002	.000	.002	.000
mean MAE	.682	.471	1.024	.682	.922	.736
distrib of observations:						
state 1	0		0		0	
state 2	23		22		1	
state 3	24		20		33	
state 4	0		0		0	
state 5	0		0		0	
Total	47		42		34	

Table 6: Summary Data for Model Delta

	Forecast Period					
	5-day		10-day		30-day	
	aided	unaided	aided	unaided	aided	unaided
mean RPS	1.000	1.000	1.000	.999	1.000	.995
std error of mean	.000	.000	.000	.000	.000	.000
mean PS	1.000	1.000	1.000	1.000	1.000	1.000
std error of mean	.000	.000	.000	.000	.000	.000
mean MAE	.000	.051	.000	.120	.000	.209
distrib of observations:						
state 1	101		101		97	
state 2	0		0		0	
state 3	0		0		0	
state 4	0		0		0	
state 5	0		0		0	
Total	101		101		97	

Table 7: Summary Data for Model Epsilon

	Forecast Period					
	5-day		10-day		30-day	
	aided	unaided	aided	unaided	aided	unaided
mean RPS	1.000	.967	1.000	.963	1.000	.947
std error of mean	.000	.002	.000	.002	.000	.004
mean PS	1.000	.877	1.000	.864	.998	.798
std error of mean	.000	.009	.000	.009	.000	.018
mean MAE	.000	.408	.000	.434	.040	.498
distrib of observations:						
state 1	0		0		0	
state 2	0		0		0	
state 3	0		0		0	
state 4	126		121		102	
state 5	0		0		0	
Total	126		121		102	

Table 8: Summary Data for Model Lambda

	Forecast Period					
	5-day		10-day		30-day	
	aided	unaided	aided	unaided	aided	unaided
mean RPS	.935	.959	.903	.956	.867	.957
std error of mean	.002	.002	.001	.002	.002	.002
mean PS	1.000	1.000	1.000	1.000	1.000	1.000
std error of mean	.000	.000	.000	.000	.000	.000
mean MAE	.525	.449	.644	.468	.830	.469
distrib of observations:						
state 1	0		0		0	
state 2	102		98		83	
state 3	6		5		0	
state 4	0		0		0	
state 5	0		0		0	
Total	108		103		83	

assessments and the computer forecasts do an excellent job of prediction.

5.0 CONCLUSIONS

Too many of the models constructed turned out to be too easy for analysts (and the PREDICT software) to forecast accurately. In these instances, the PREDICT system succeeded in producing nearly perfect forecasts; thus, while the rather complex mathematical model was not afforded an opportunity to do better than the analysts' direct assessments, it did pass a less stringent test by not performing markedly worse than the unaided analysts.

In the case of the one model which had sufficient difficulty and exhibited frequent state changes (Alpha), the unaided forecasts were superior to the PREDICT-generated forecasts for the 5-day and 10-day forecasts and the PREDICT forecast was superior for the 30-day forecasts. The sizes of observed effects are such that the PREDICT model would appear to be able to substitute successfully for an analyst during periods of absence or overload in cases similar to those modeled here.

The data provide a suggestion that for longer-term forecasts in dynamic situations the PREDICT system could serve to improve the quality of analysts' forecasts. For the one case observed, the magnitude of the improvement from computer-aiding is 20% of the value of the unaided forecast when using a baseline uniform forecast for comparison.

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APPENDIX: DATA TABLES

A.1 Format of Tables

The data for unaided forecasts are presented in relatively unprocessed form in Subsection A.2, with the corresponding data for computer-generated forecasts in Subsection A.3. The formats of both data files are identical. To illustrate concretely, consider page 1 of the listing of file "ALPHA.UFN" (Alpha-unaided). Data are presented on one line for each day. The first line is always 1 June 1981. Each successive line is the following day. For each line, 17 fields (items) of varying width are presented. Field one is a three-digit date (month and day); it is shown only for those days on which probability forecasts were collected from the analyst. The first date on which forecasts were generated was June 23. The second field is the state actually observed by the analyst on that date. Thus model Alpha was reported to be in state 3 on June 23.

The remaining fifteen 3-digit fields show the probabilities (on a 0 to 100 integer scale) assessed for that date, the first five fields corresponding to the probabilities of states one through five forecast 5 days earlier, the next five for the forecast produced 10 days earlier, and the last five for the forecast generated 30 days earlier, all forecasts pertaining to the date corresponding to the particular line. Five zeroes for a forecast indicates no forecast was collected. Thus for June 23 no forecasts were available for the states on that date. For June 28, a forecast produced five days earlier indicated probabilities of 0.01 each for states 1 and 2, 0.40 for state 3 (the state actually observed on that date), 0.50 for state 4, and 0.08 for state 5; no forecasts for June 28 were available corresponding to 10-day and 30-day intervals. Dates are shown as zero for days on which forecasts were not collected; thus no forecasts were generated on June 28. In general, even when forecasts were not generated, the observed states for those days were estimated at the next forecasting session.

A.2 Data for Unaided Forecasts

A.2.1 Alpha.

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MAY 26 13:36 1982  ALPHA.UFN PAGE      1

  0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
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A.2.2 Beta.

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914	3	0	1	97	2	0	0	2	91	7	0	1	6	80	12	1
915	0	0	1	97	2	0	0	2	91	7	0	1	6	80	12	1
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920	0	0	1	97	2	0	0	2	91	7	0	1	6	80	12	1

```
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 925 0  0  1 97  2  0  0  2 91  7  0  1  6 30 12  1
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1005 0  0  1 97  2  0  0  2 91  7  0  1  6 75 15  3
1006 0  0  1 97  2  0  0  2 91  7  0  1  6 75 15  3
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1021 0  0  1 97  2  0  0  2 95  3  0  1  6 75 15  3
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A.2.3. Gamma.

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0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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MAY 26 13:37 1982  GAMMA.UFN PAGE      2

 727 2   0 45 45 10  0  0  0  0  0  0  0  0  0  0  0
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 731 3   0  0  0  0  0  0 45 45  5  5 15 40 35  5  5
   0 3   0 45 35 15  5  0 45 40 10  5 15 40 30 10  5
   0 3   0 45 40 15  0  5 45 45  5  0  0  0  0  0  0
 803 3   0 40 40 15  5  0  0  0  0  0  0  0  0  0  0
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   0 3   0 55 35 10  0  0  0  0  0  0  5 50 30 10  5
   0 3   0  0  0  0  0  0 40 40 15  5  0  0  0  0  0
   0 3   0  0  0  0  0  0 40 45 15  0  0  0  0  0  0
   0 3   0 50 45  5  0  0 40 35 20  5  0  0  0  0  0
   0 3   0  0  0  0  0  0 50 25 20  5  0  0  0  0  0
   0 3   0  0  0  0  0  0 60 30  5  5  0  0  0  0  0
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   0 3   0  0  0  0  0  0  0  0  0  0  0 50 35 10  5
   0 3   0  0  0  0  0  0  0  0  0  0  5 50 35  5  5
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 827 3   0  0  0  0  0  0  0  0  0  0  5 40 25 25  5
   0 3   0  0  0  0  0  0  0  0  0  0  0 50 30 15  5
   0 3   0 30 60  5  5  0  0  0  0  0  0 60 20 15  5
   0 3   0 35 55  5  5  0  0  0  0  0  0 55 35  5  5
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 903 2   0  0  0  0  0  5 30 55  5  5  0  0  0  0  0
 904 2   0  0  0  0  0  0 45 45  5  5  0  0  0  0  0
 905 2   0 20 70  5  5  0 35 55  5  5  0  0  0  0  0
 906 2   0 30 65  5  0  0 20 70  5  5  0  0  0  0  0
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   0 2   0 55 45  0  0  0  0  0  0  0  0  0  0  0  0
   0 2   0 60 40  0  0  0 20 65 10  5  0  0  0  0  0
   0 2   0 55 45  0  0  0 35 55  5  5  0  0  0  0  0
   0 2   0 50 50  0  0  0 55 40  5  0  0  0  0  0  0
   0 2   0  0  0  0  0  0 50 45  5  0  0  0  0  0  0
 914 2   0  0  0  0  0  0 50 45  5  0  0  0  0  0  0
 915 2   0  0  0  0  0  0 60 35  5  0  0  0  0  0  0
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 918 3   0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
   0 3   0 50 45  5  0  0  0  0  0  0  0  0  0  0  0
   0 3   0 45 50  5  0  0  0  0  0  0  0  0  0  0  0
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1019	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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0	2	0	75	25	0	0	0	0	0	0	0	0	0	0	0	0
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A.2.4. Delta.

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MAY 26 13:38 1982  DELTA.UFN PAGE      3

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A.2.5. Epsilon.

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A.2.6. Lambda.

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A.3 Data for Aided Forecasts

A.3.1 Alpha.

```
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     0 0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
     0 0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
     0 0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
     0 0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
     0 0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
     0 0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
     0 0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
     0 0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
     0 0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
     0 0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
     0 0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
     0 0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
     0 0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
     0 0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
     0 0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
     0 0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
     0 0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
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     0 0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
     0 0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
     0 0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
     0 0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
   623 3   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
   624 3   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
   625 3   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
   626 3   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
   627 3   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
   628 3   0   2  41  32  25   0   0   0   0   0   0   0   0   0   0
   629 3   0   2  38  47  13   0   0   0   0   0   0   0   0   0   0
   630 3   0   2  31  54  13   0   0   0   0   0   0   0   0   0   0
   701 4   0   2  31  57  10   0   0   0   0   0   0   0   0   0   0
   702 4   0   2  30  60   8   0   0   0   0   0   0   0   0   0   0
   703 3   0   2  30  61   6   0   5  37  23  35   0   0   0   0   0
   704 3   0   2  30  62   6   0   5  29  47  19   0   0   0   0   0
   705 3   0   2  29  63   5   0   5  28  54  13   0   0   0   0   0
   706 3   0   0  27  19  54   0   5  27  58  10   0   0   0   0   0
   707 4   0   0  27  17  56   0   5  27  61   8   0   0   0   0   0
   708 4   0   2  31  64   3   0   5  26  62   7   0   0   0   0   0
   709 4   0   2  28  66   3   0   5  26  63   6   0   0   0   0   0
   710 4   0   2  28  67   3   0   5  26  64   5   0   0   0   0   0
   711 4   0   2  28  67   3   0   0  30  15  54   0   0   0   0   0
   712 4   0   0  30  18  52   0   0  31  12  57   0   0   0   0   0
   713 4   0   0  30  16  54   0   4  28  64   4   0   0   0   0   0
   714 4   0   0  30  16  54   0   5  25  67   3   0   0   0   0   0
   715 4   0   0  30  16  54   0   5  25  67   3   0   0   0   0   0
   716 4   0   0  30  16  54   0   5  25  67   3   0   0   0   0   0
   717 4   0   0  30  16  54   0   0  33  14  53   0   0   0   0   0
   718 3   0   0  30  16  54   0   0  34  11  55   0   0   0   0   0
   719 3   0   0  30  16  54   0   0  34  11  55   0   0   0   0   0
   720 3   0   0  30  16  54   0   0  34  11  55   0   0   0   0   0
   721 2   0   0  30  16  54   0   0  34  11  55   0   0   0   0   0
   722 2   0   0  30  16  54   0   0  34  11  55   0   0   0   0   0
   723 2   0   2  30  67   1   0   0  34  11  55   0  10  31  20  40
   724 3   0   2  27  69   1   0   0  34  11  55   0   8  16  50  26
   725 3   0   2  27  70   1   0   0  34  11  55   0   8  15  56  21
   726 3   0  96   4   0   0   0   0  34  11  55   0   8  14  60  19
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728	3	0	95	5	0	0	0	4	27	67	2	0	8	13	63	16
729	3	0	9	25	65	1	0	5	24	70	2	0	8	13	64	15
730	3	0	9	23	67	1	0	5	24	70	1	0	8	13	65	14
731	3	0	9	23	67	1	0	90	10	0	0	0	0	32	13	54
301	3	0	0	33	17	50	0	89	11	0	0	0	0	33	10	57
302	3	0	9	25	65	1	0	88	11	0	0	0	7	16	64	12
303	3	0	9	22	68	1	0	10	24	65	1	0	7	13	67	13
304	4	0	9	22	68	1	0	10	21	68	1	0	7	13	67	12
305	4	0	9	22	68	1	0	10	21	68	1	0	7	13	68	12
306	5	0	9	22	68	1	0	0	35	14	51	0	0	34	13	52
307	5	0	9	22	68	1	0	10	24	66	1	0	0	35	9	56
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309	5	0	0	35	17	48	0	10	20	69	1	0	0	35	9	56
310	5	0	0	35	14	50	0	10	20	69	1	0	0	35	9	56
311	5	0	0	6	28	66	0	10	20	69	1	0	0	35	9	56
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314	4	0	0	7	36	57	0	0	37	13	49	0	0	35	9	56
315	4	0	0	7	36	57	0	0	38	10	52	0	0	35	9	56
316	4	0	0	7	36	57	0	0	13	49	38	0	0	35	9	56
317	4	0	0	7	36	57	0	0	14	50	36	0	7	16	67	10
318	4	0	0	34	17	50	0	0	14	50	36	0	7	13	70	11
319	4	0	0	34	14	52	0	0	14	50	36	0	7	13	70	10
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321	4	0	0	34	14	52	0	0	14	50	36	0	75	20	1	4
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323	4	0	0	34	14	52	0	0	36	13	51	0	10	15	65	9
324	4	0	0	34	14	52	0	0	37	9	53	0	11	12	63	10
325	4	0	0	34	14	52	0	0	37	9	53	0	11	12	63	10
326	4	0	0	34	14	52	0	0	37	9	53	0	0	36	13	51
327	4	0	0	34	14	52	0	0	37	9	53	0	10	15	66	9
328	4	0	0	34	14	52	0	0	37	9	53	0	10	12	69	9
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903	4	0	0	34	14	52	0	0	37	9	53	0	0	38	13	49
904	4	0	0	34	14	52	0	0	37	9	53	0	0	39	9	52
905	4	0	0	34	14	52	0	0	37	9	53	0	0	26	52	22
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910	4	0	0	34	14	52	0	0	37	9	53	0	0	26	52	22
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912	4	0	0	34	14	52	0	0	37	9	53	0	0	37	12	51
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914	4	0	0	34	14	52	0	0	37	9	53	0	0	38	9	53
915	5	0	0	34	14	52	0	0	37	9	53	0	0	38	9	53
916	5	0	0	34	14	52	0	0	37	9	53	0	0	38	9	53
917	5	0	0	34	14	52	0	0	37	9	53	0	0	38	9	53
918	5	0	0	34	14	52	0	0	37	9	53	0	0	38	9	53
919	5	0	0	34	14	52	0	0	37	9	53	0	0	38	9	53
920	5	0	0	6	43	46	0	0	37	9	53	0	0	38	9	53

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 921 5   0   0   7  52  42   0   0 37   9 53   0   0 38   9 53
 922 5   0   0   7  52  42   0   0 37   9 53   0   0 38   8 53
 923 5   0   0   7  52  42   0   0 37   9 53   0   0 38   8 53
 924 5   0   0   7  52  42   0   0 37   9 53   0   0 38   8 53
 925 5   0   0   7  52  42   0   0 12  49 39   0   0 38   8 53
 926 5   0   0   7  52  42   0   0 13  52 35   0   0 38   8 53
 927 5   0   0   7  52  42   0   0 13  52 35   0   0 38   8 53
 928 5   0   0   7  52  42   0   0 13  52 35   0   0 38   8 53
 929 5   0   0   7  52  42   0   0 13  52 35   0   0 38   8 53
 930 5   0   0   7  52  42   0   0 13  52 35   0   0 38   8 53
1001 5   0   0   7  52  42   0   0 13  52 35   0   0 38   8 53
1002 5   0   0   7  52  42   0   0 13  52 35   0   0 38   8 53
1003 5   0   0   7  52  42   0   0 13  52 35   0   0 38   8 53
1004 5   0   0   7  52  42   0   0 13  52 35   0   0 38   8 53
1005 5   0   0   7  52  42   0   0 13  52 35   0   0 38   8 53
1006 5   0   0   7  52  42   0   0 13  52 35   0   0 38   8 53
1007 5   0   0   7  52  42   0   0 13  52 35   0   0 38   8 53
1008 5   0   0   7  52  42   0   0 13  52 35   0   0 38   8 53
1009 5   0   0   7  52  42   0   0 13  52 35   0   0 38   8 53
1010 5   0   0   7  52  42   0   0 13  52 35   0   0 38   8 53
1011 5   0   0   7  52  42   0   0 13  52 35   0   0 38   8 53
1012 5   0   0   7  52  42   0   0 13  52 35   0   0 38   8 53
1013 5   0   0   7  52  42   0   0 13  52 35   0   0 38   8 53
1014 5   0   0   7  52  42   0   0 13  52 35   0   0 38   8 53
1015 5   0   0   7  52  42   0   0 13  52 35   0   0 25  49 27
   0 0   0   0   7  52  41   0   0 13  52 35   0   0 25  52 23
   0 0   0   0   7  52  41   0   0 13  52 35   0   0 25  52 23
   0 0   0   0   7  52  41   0   0 13  52 35   0   0 25  52 23
   0 0   0   0   7  52  41   0   0 13  52 35   0   0 25  52 23
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   0 0   0   0   0   0   0   0   0 13  52 35   0   0 25  52 23
   0 0   0   0   0   0   0   0   0 13  52 35   0   0 25  52 23
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   0 0   0   0   0   0   0   0   0  0   0  0   0   0 25  52 23
   0 0   0   0   0   0   0   0   0  0   0  0   0   0  0   0  0
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A.3.2 Beta.

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      0  0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
      0  0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
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      0  0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
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      0  0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
      0  0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
      0  0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
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    627  3   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
    628  3   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
    629  3   0   7  91   2   0   0   0   0   0   0   0   0   0   0   0
    630  3   0   7  91   2   0   0   0   0   0   0   0   0   0   0   0
    701  3   0   7  91   2   0   0   0   0   0   0   0   0   0   0   0
    702  3   0   7  91   2   0   0   0   0   0   0   0   0   0   0   0
    703  3   0   7  91   2   0   0   0   0   0   0   0   0   0   0   0
    704  3   0   7  91   2   0   0  32  30  33   0   0   0   0   0   0
    705  3   0   7  91   2   0   0  32  30  33   0   0   0   0   0   0
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    707  3   0   7  91   2   0   0  32  30  33   0   0   0   0   0   0
    708  3   0   7  91   2   0   0  32  30  33   0   0   0   0   0   0
    709  3   0   7  91   2   0   0  32  30  33   0   0   0   0   0   0
    710  3   0   7  91   2   0   0  32  30  33   0   0   0   0   0   0
    711  3   0   7  91   2   0   0  32  30  33   0   0   0   0   0   0
    712  3   0   7  91   2   0   0  32  30  33   0   0   0   0   0   0
    713  3   0   7  91   2   0   0  32  30  33   0   0   0   0   0   0
    714  3   0   7  91   2   0   0  32  30  33   0   0   0   0   0   0
    715  3   0   7  91   2   0   0  32  30  33   0   0   0   0   0   0
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    718  3   0   7  91   2   0   0  32  30  33   0   0   0   0   0   0
    719  3   0   7  91   2   0   0  32  30  33   0   0   0   0   0   0
    720  3   0   7  91   2   0   0  32  30  33   0   0   0   0   0   0
    721  3   0   7  91   2   0   0  32  30  33   0   0   0   0   0   0
    722  3   0   7  91   2   0   0  32  30  33   0   0   0   0   0   0
    723  3   0   7  91   2   0   0  32  30  33   0   0   0   0   0   0
    724  3   0   7  91   2   0   0  32  30  33   0   0  36  34  22   7
    725  3   0   7  91   2   0   0  32  30  33   0   0  41  22  34   4
    726  3   0   7  91   2   0   0  32  30  33   0   0  42  18  37   3
```

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727  3   0   7  91   2   0   0  32  30  38   0   0  43  16  39   2
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730  3   0   7  91   2   0   0  32  30  38   0   0  44  13  42   2
731  3   0   7  91   2   0   0  32  30  38   0   0  44  13  42   1
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A.3.3 Gamma.

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   0  0   3 67 29  1  0  7 43 38  3  4  3 31 14 34 17
   0  0   3 67 29  1  0  7 43 38  3  4  3 31 14 34 17
   0  0   0  0  0  0  0  7 43 38  3  4  3 31 14 34 17
   0  0   0  0  0  0  0  7 43 38  3  4  3 31 14 34 17
   0  0   0  0  0  0  0  7 43 38  3  4  3 31 14 34 17
   0  0   0  0  0  0  0  7 43 39  3  4  3 31 14 34 17
   0  0   0  0  0  0  0  7 43 39  3  4  3 31 14 34 17
   0  0   0  0  0  0  0  0  0  0  0  0  3 31 14 34 17
```

A.3.4 Delta.

```
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  0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
630 1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
701 1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
702 1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
703 1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
704 1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
705 1100  0  0  0  0  0  0  0  0  0  0  0  0  0  0
706 1100  0  0  0  0  0  0  0  0  0  0  0  0  0  0
707 1100  0  0  0  0  0  0  0  0  0  0  0  0  0  0
708 1100  0  0  0  0  0  0  0  0  0  0  0  0  0  0
709 1100  0  0  0  0  0  0  0  0  0  0  0  0  0  0
710 1100  0  0  0  0100  0  0  0  0  0  0  0  0  0
711 1100  0  0  0  0100  0  0  0  0  0  0  0  0  0
712 1100  0  0  0  0100  0  0  0  0  0  0  0  0  0
713 1100  0  0  0  0100  0  0  0  0  0  0  0  0  0
714 1100  0  0  0  0100  0  0  0  0  0  0  0  0  0
715 1100  0  0  0  0100  0  0  0  0  0  0  0  0  0
716 1100  0  0  0  0100  0  0  0  0  0  0  0  0  0
717 1100  0  0  0  0100  0  0  0  0  0  0  0  0  0
718 1100  0  0  0  0100  0  0  0  0  0  0  0  0  0
719 1100  0  0  0  0100  0  0  0  0  0  0  0  0  0
720 1100  0  0  0  0100  0  0  0  0  0  0  0  0  0
721 1100  0  0  0  0100  0  0  0  0  0  0  0  0  0
722 1100  0  0  0  0100  0  0  0  0  0  0  0  0  0
723 1100  0  0  0  0100  0  0  0  0  0  0  0  0  0
724 1100  0  0  0  0100  0  0  0  0  0  0  0  0  0
725 1100  0  0  0  0100  0  0  0  0  0  0  0  0  0
726 1100  0  0  0  0100  0  0  0  0  0  0  0  0  0
```

727	1100	0	0	0	0100	0	0	0	0	0	0	0	0	0
728	1100	0	0	0	0100	0	0	0	0	0	0	0	0	0
729	1100	0	0	0	0100	0	0	0	0	0	0	0	0	0
730	1100	0	0	0	0100	0	0	0	0	99	0	0	0	0
731	1100	0	0	0	0100	0	0	0	0	99	0	0	0	0
301	1100	0	0	0	0100	0	0	0	0	99	0	0	0	0
302	1100	0	0	0	0100	0	0	0	0	99	0	0	0	0
303	1100	0	0	0	0100	0	0	0	0	99	0	0	0	0
304	1100	0	0	0	0100	0	0	0	0	99	0	0	0	0
305	1100	0	0	0	0100	0	0	0	0	99	0	0	0	0
306	1100	0	0	0	0100	0	0	0	0	99	0	0	0	0
307	1100	0	0	0	0100	0	0	0	0	99	0	0	0	0
308	1100	0	0	0	0100	0	0	0	0	99	0	0	0	0
309	1100	0	0	0	0100	0	0	0	0	99	0	0	0	0
310	1100	0	0	0	0100	0	0	0	0	99	0	0	0	0
311	1100	0	0	0	0100	0	0	0	0	99	0	0	0	0
312	1100	0	0	0	0100	0	0	0	0	99	0	0	0	0
313	1100	0	0	0	0100	0	0	0	0	99	0	0	0	0
314	1100	0	0	0	0100	0	0	0	0	99	0	0	0	0
315	1100	0	0	0	0100	0	0	0	0	99	0	0	0	0
316	1100	0	0	0	0100	0	0	0	0	99	0	0	0	0
317	1100	0	0	0	0100	0	0	0	0	99	0	0	0	0
318	1100	0	0	0	0100	0	0	0	0	99	0	0	0	0
319	1100	0	0	0	0100	0	0	0	0	99	0	0	0	0
320	1100	0	0	0	0100	0	0	0	0	99	0	0	0	0
321	1100	0	0	0	0100	0	0	0	0	99	0	0	0	0
322	1100	0	0	0	0100	0	0	0	0	99	0	0	0	0
323	1100	0	0	0	0100	0	0	0	0	99	0	0	0	0
324	1100	0	0	0	0100	0	0	0	0	99	0	0	0	0
325	1100	0	0	0	0100	0	0	0	0	99	0	0	0	0
326	1100	0	0	0	0100	0	0	0	0	99	0	0	0	0
327	1100	0	0	0	0100	0	0	0	0	99	0	0	0	0
328	1100	0	0	0	0100	0	0	0	0	99	0	0	0	0
329	1100	0	0	0	0100	0	0	0	0	99	0	0	0	0
330	1100	0	0	0	0100	0	0	0	0	99	0	0	0	0
331	1100	0	0	0	0100	0	0	0	0	99	0	0	0	0
301	1100	0	0	0	0100	0	0	0	0	99	0	0	0	0
302	1100	0	0	0	0100	0	0	0	0	99	0	0	0	0
303	1100	0	0	0	0100	0	0	0	0	99	0	0	0	0
304	1100	0	0	0	0100	0	0	0	0	99	0	0	0	0
305	1100	0	0	0	0100	0	0	0	0	99	0	0	0	0
306	1100	0	0	0	0100	0	0	0	0	99	0	0	0	0
307	1100	0	0	0	0100	0	0	0	0	99	0	0	0	0
308	1100	0	0	0	0100	0	0	0	0	99	0	0	0	0
309	1100	0	0	0	0100	0	0	0	0	99	0	0	0	0
310	1100	0	0	0	0100	0	0	0	0	99	0	0	0	0
311	1100	0	0	0	0100	0	0	0	0	99	0	0	0	0
312	1100	0	0	0	0100	0	0	0	0	99	0	0	0	0
313	1100	0	0	0	0100	0	0	0	0	99	0	0	0	0
314	1100	0	0	0	0100	0	0	0	0	99	0	0	0	0
315	1100	0	0	0	0100	0	0	0	0	99	0	0	0	0
316	1100	0	0	0	0100	0	0	0	0	99	0	0	0	0
317	1100	0	0	0	0100	0	0	0	0	99	0	0	0	0
318	1100	0	0	0	0100	0	0	0	0	99	0	0	0	0
319	1100	0	0	0	0100	0	0	0	0	99	0	0	0	0
320	1100	0	0	0	0100	0	0	0	0	99	0	0	0	0

```
 921 1100  0  0  0 0100  0  0  0  0 99  0  0  0  0
 922 1100  0  0  0 0100  0  0  0  0 99  0  0  0  0
 923 1100  0  0  0 0100  0  0  0  0 99  0  0  0  0
 924 1100  0  0  0 0100  0  0  0  0 99  0  0  0  0
 925 1100  0  0  0 0100  0  0  0  0 99  0  0  0  0
 926 1100  0  0  0 0100  0  0  0  0 99  0  0  0  0
 927 1100  0  0  0 0100  0  0  0  0 99  0  0  0  0
 928 1100  0  0  0 0100  0  0  0  0 99  0  0  0  0
 929 1100  0  0  0 0100  0  0  0  0 99  0  0  0  0
 930 1100  0  0  0 0100  0  0  0  0 99  0  0  0  0
1001 1100  0  0  0 0100  0  0  0  0 99  0  0  0  0
1002 1100  0  0  0 0100  0  0  0  0 99  0  0  0  0
1003 1100  0  0  0 0100  0  0  0  0 99  0  0  0  0
1004 1100  0  0  0 0100  0  0  0  0 99  0  0  0  0
1005 1100  0  0  0 0100  0  0  0  0 99  0  0  0  0
1006 1100  0  0  0 0100  0  0  0  0 99  0  0  0  0
1007 1100  0  0  0 0100  0  0  0  0 99  0  0  0  0
1008 1100  0  0  0 0100  0  0  0  0 99  0  0  0  0
1009 1100  0  0  0 0100  0  0  0  0 99  0  0  0  0
1010 1100  0  0  0 0100  0  0  0  0 99  0  0  0  0
1011 1100  0  0  0 0100  0  0  0  0 99  0  0  0  0
1012 1100  0  0  0 0100  0  0  0  0 99  0  0  0  0
1013 1100  0  0  0 0100  0  0  0  0 99  0  0  0  0
1014 1100  0  0  0 0100  0  0  0  0 99  0  0  0  0
1015 1100  0  0  0 0100  0  0  0  0 99  0  0  0  0
1016 1100  0  0  0 0100  0  0  0  0 99  0  0  0  0
1017 1100  0  0  0 0100  0  0  0  0 99  0  0  0  0
1018 1100  0  0  0 0100  0  0  0  0 99  0  0  0  0
1019 1100  0  0  0 0100  0  0  0  0 99  0  0  0  0
1020 1100  0  0  0 0100  0  0  0  0 99  0  0  0  0
1021 1100  0  0  0 0100  0  0  0  0 99  0  0  0  0
1022 1100  0  0  0 0100  0  0  0  0 99  0  0  0  0
1023 1100  0  0  0 0100  0  0  0  0 99  0  0  0  0
1024 1100  0  0  0 0100  0  0  0  0 99  0  0  0  0
1025 1100  0  0  0 0100  0  0  0  0 99  0  0  0  0
1026 1100  0  0  0 0100  0  0  0  0 99  0  0  0  0
1027 1100  0  0  0 0100  0  0  0  0 99  0  0  0  0
1028 1100  0  0  0 0100  0  0  0  0 99  0  0  0  0
1029 1100  0  0  0 0100  0  0  0  0 99  0  0  0  0
1030 1100  0  0  0 0100  0  0  0  0 99  0  0  0  0
1031 1100  0  0  0 0100  0  0  0  0 99  0  0  0  0
1101 1100  0  0  0 0100  0  0  0  0 99  0  0  0  0
1102 1100  0  0  0 0100  0  0  0  0 99  0  0  0  0
1103 1100  0  0  0 0100  0  0  0  0 99  0  0  0  0
1104 1100  0  0  0 0100  0  0  0  0 99  0  0  0  0
   0 0100  0  0  0 0100  0  0  0  0 99  0  0  0  0
   0 0100  0  0  0 0100  0  0  0  0 99  0  0  0  0
   0 0100  0  0  0 0100  0  0  0  0 99  0  0  0  0
   0 0100  0  0  0 0100  0  0  0  0 99  0  0  0  0
   0 0100  0  0  0 0100  0  0  0  0 99  0  0  0  0
   0 0  0  0  0  0 0100  0  0  0  0 99  0  0  0  0
   0 0  0  0  0  0 0100  0  0  0  0 99  0  0  0  0
   0 0  0  0  0  0 0100  0  0  0  0 99  0  0  0  0
   0 0  0  0  0  0 0100  0  0  0  0 99  0  0  0  0
   0 0  0  0  0  0 0100  0  0  0  0 99  0  0  0  0
   0 0  0  0  0  0  0  0  0  0  0  0 99  0  0  0  0
```

A.3.5 Epsilon.

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      0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
      0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
      0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
      0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
      0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
      0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
      0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
      0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
      0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
      0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
      0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
      0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
      0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
      0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
      0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
      0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
      0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
      0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
      0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
      0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
      0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
      0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
      0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
      0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
      0 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
    626 4  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
    627 4  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
    628 4  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
    629 4  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
    630 4  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
    701 4  0  0  0100  0  0  0  0  0  0  0  0  0  0  0
    702 4  0  0  0100  0  0  0  0  0  0  0  0  0  0  0
    703 4  0  0  0100  0  0  0  0  0  0  0  0  0  0  0
    704 4  0  0  0100  0  0  0  0  0  0  0  0  0  0  0
    705 4  0  0  0100  0  0  0  0  0  0  0  0  0  0  0
    706 4  0  0  0100  0  0  0  0100  0  0  0  0  0  0
    707 4  0  0  0100  0  0  0  0100  0  0  0  0  0  0
    708 4  0  0  0100  0  0  0  0100  0  0  0  0  0  0
    709 4  0  0  0100  0  0  0  0100  0  0  0  0  0  0
    710 4  0  0  0100  0  0  0  0100  0  0  0  0  0  0
    711 4  0  0  0100  0  0  0  0100  0  0  0  0  0  0
    712 4  0  0  0100  0  0  0  0100  0  0  0  0  0  0
    713 4  0  0  0100  0  0  0  0100  0  0  0  0  0  0
    714 4  0  0  0100  0  0  0  0100  0  0  0  0  0  0
    715 4  0  0  0100  0  0  0  0100  0  0  0  0  0  0
    716 4  0  0  0100  0  0  0  0100  0  0  0  0  0  0
    717 4  0  0  0100  0  0  0  0100  0  0  0  0  0  0
    718 4  0  0  0100  0  0  0  0100  0  0  0  0  0  0
    719 4  0  0  0100  0  0  0  0100  0  0  0  0  0  0
    720 4  0  0  0100  0  0  0  0100  0  0  0  0  0  0
    721 4  0  0  0100  0  0  0  0100  0  0  0  0  0  0
    722 4  0  0  0100  0  0  0  0100  0  0  0  0  0  0
    723 4  0  0  0100  0  0  0  0100  0  0  0  0  0  0
    724 4  0  0  0100  0  0  0  0100  0  0  0  0  0  0
    725 4  0  0  0100  0  0  0  0100  0  0  0  0  0  0
    726 4  0  0  0100  0  0  0  0100  0  0  0  0 97  3
```

727	4	0	0	0100	0	0	0	0100	0	0	0	0	97	3
728	4	0	0	0100	0	0	0	0100	0	0	0	0	97	3
729	4	0	0	0100	0	0	0	0100	0	0	0	0	97	3
730	4	0	0	0100	0	0	0	0100	0	0	0	0	97	3
731	4	0	0	0100	0	0	0	0100	0	0	0	0	96	4
801	4	0	0	0100	0	0	0	0100	0	0	0	0	96	4
802	4	0	0	0100	0	0	0	0100	0	0	0	0	96	4
803	4	0	0	0100	0	0	0	0100	0	0	0	0	96	4
804	4	0	0	0100	0	0	0	0100	0	0	0	0	96	4
805	4	0	0	0100	0	0	0	0100	0	0	0	0	96	4
806	4	0	0	0100	0	0	0	0100	0	0	0	0	96	4
807	4	0	0	0100	0	0	0	0100	0	0	0	0	96	4
808	4	0	0	0100	0	0	0	0100	0	0	0	0	96	4
809	4	0	0	0100	0	0	0	0100	0	0	0	0	96	4
810	4	0	0	0100	0	0	0	0100	0	0	0	0	96	4
811	4	0	0	0100	0	0	0	0100	0	0	0	0	96	4
812	4	0	0	0100	0	0	0	0100	0	0	0	0	96	4
813	4	0	0	0100	0	0	0	0100	0	0	0	0	96	4
814	4	0	0	0100	0	0	0	0100	0	0	0	0	96	4
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A.3.6 Lambda.

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MAY 25 16:41 1982  LAMBDA.AID PAGE      1

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0	0	0	0	0	0	0	0	0	0	0	0	4	21	70	4	0
0	0	0	0	0	0	0	0	0	0	0	0	4	21	70	4	0
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0	0	0	0	0	0	0	0	0	0	0	0	4	21	70	4	0
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0	0	0	0	0	0	0	0	0	0	0	0	4	21	70	4	0

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